

A New Harness For Use with Exercise Countermeasures-Validation of Improved Comfort and Loading with the Center for Space Medicine (CSM) Harness

Completed Technology Project (2008 - 2011)



Project Introduction

This Station Development Test Objective (SDTO) assesses whether crewmembers can exercise more comfortably and at higher loads using a new treadmill harness developed through the Center for Space Medicine (CSM) and identified as the CSM Harness, as compared to the existing International Space Station (ISS) treadmill harness. The hypotheses are as follows: i) the CSM Harness will provide greater overall comfort than the current U.S. Treadmill with Vibration Isolation and Stabilization System (TVIS) harness (hereafter referred to as the ISS treadmill harness); ii) crewmembers will be able to tolerate higher external loads from the subject load device and/or Series Bungee System (SBS) Bungees; iii) load distribution measurements collected with strain-gage-based buckle transducer instrumentation between shoulders and hips will correlate with subjective measures of comfort; and iv) the CSM Harness will provide more effective wear and adjustability (easier adjustments, and adjustments will stay fixed once they are set, breathable biocide outer fabric, etc.).

The CSM Harness design has potential to improve comfort, wear, and adjustment effectiveness on-orbit. To support this SDTO, NASA Glenn Research Center (GRC) delivered seven (7) flight-certified CSM Harnesses with buckle transducer instrumentation and the instrumentation for 7 ISS treadmill harnesses plus spares. The buckle transducer instrumentation will converge at a junction box, which shall interface with the Ambulatory Data Acquisition System (ADAS) for data recording. The ADAS has previously flown as payload hardware sponsored by the ISS Medical Project (ISSMP) for the Foot Experiment (Experiment Identifier: #96-E318, ISS Expeditions 6, 8, 11, 12) and will be provided by ISSMP. Subject loading data will be collected for eight total sessions in-flight (4 with each harness) with each of five subjects as part of this SDTO. For these 8 sessions, a unique harness evaluation protocol will be followed for the crewmembers' nominal treadmill exercise session.

The SDTO research protocol is aimed at improving comfort, plus increasing consistent loading for crewmembers exercising on the ISS treadmill(s). The CSM Harnesses will be instrumented to allow for objective correlation with subjective ratings of comfort. To provide a direct comparison with the ISS treadmill harness, the load distribution and subject load device loading applied to the ISS treadmill harness will also be measured. The ISS treadmill harnesses will be instrumented by the crew on-orbit during a one-time set up activity. Current monitoring does not allow measurement of inflight load distribution of the harness or the applied external load – these objective data sets may be correlated with subjective comfort data for improved designs and for existing and advanced concept exercise countermeasures systems requiring crewmember harnessing.

Anticipated Benefits



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For more information and an accessible alternative, please visit:
<https://techport.nasa.gov/view/23209>

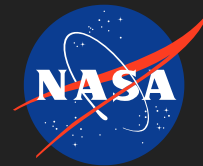
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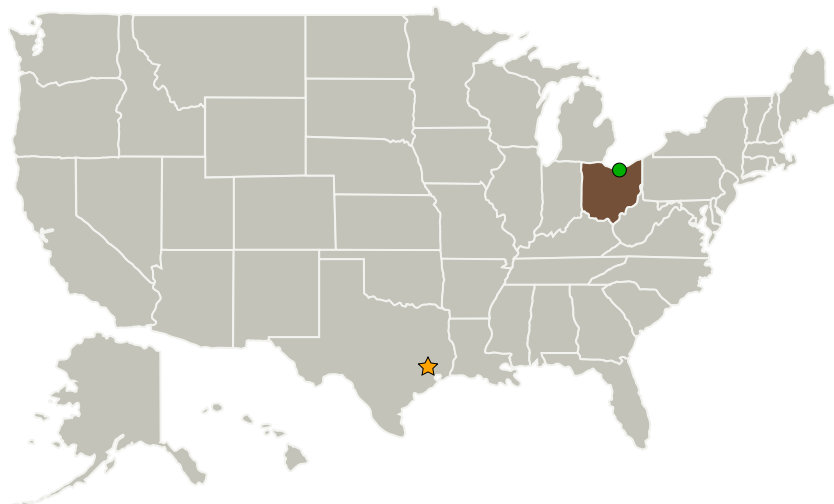
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Improved harnessing may be utilized in ground-based simulators (e.g., the enhanced Zero-gravity Locomotion Simulator at NASA Glenn and/or the standalone Zero-gravity Locomotion Simulator at University of Texas Medical Branch) for human test subjects research including bed rest studies.

Improved harnessing may improve crewmember comfort during treadmill exercise aboard the International Space Station, reduce chafing, bruising, scarring experienced currently. Improved comfort may allow crewmembers to run more readily at full body-weight on the subject loading system, thus potentially improving benefit of exercise and musculoskeletal health.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Cleveland Clinic	Supporting Organization	Industry	Cleveland, Ohio
● Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Organizational Responsibility

Responsible Mission Directorate:

Space Operations Mission Directorate (SOMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Human Spaceflight Capabilities

Project Management

Program Director:

David K Baumann

Project Manager:

Peter Norsk

Principal Investigator:

Gail P Perusek

Co-Investigator:

Tammy Owings

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Primary U.S. Work Locations

Ohio

Project Transitions



February 2008: Project Start



March 2011: Closed out

Closeout Summary: The on-orbit treadmill harness Station Development Test Objective (SDTO) evaluation ran from Increment 21 through 25 aboard the International Space Station (September 2009 through November 2010). A total of six (6) crewmembers participated in the protocol. One (1) crewmember opted out of the protocol voluntarily. Debrief sessions have occurred per nominal procedures. All crewmembers completed questionnaires after select sessions (typically every 3rd or 4th exercise session) which included a modified Borg scale for pain (0-10 scale, 10 being worst imaginable pain) for each harness in specific body areas (neck, shoulders, back, hips, waist, and overall), perceived load ratio (% load at hip vs. % load at shoulders), perceived total load, narrative responses relating to harness fit and comfort, and nine (9) questions relating to harness performance and effectiveness as ranked on a Likert scale (1 to 5, strongly disagree to strongly agree). As a top-level summary, questionnaire responses and crew debriefs confirmed that overall, one (1) crewmember preferred the ISS Treadmill harness, one (1) crewmember expressed no preference, and four (4) crewmembers preferred the Center for Space Medicine (CSM) harness. Note the Operational Nomenclature designation for the CSM harness was changed to "Glenn Harness." Load data were captured for 3 of 6 crewmembers, issues that arose were trouble shot and fixed. Post-flight inspections of returned Glenn Harnesses (n=3) showed that they held up well to wear and tear. Overall, the Glenn Harness compared favorably in this on-orbit side-by-side comparison as measured by the crew comfort questionnaire and crew debriefs. Specific areas for improvement have been identified, and forward recommendations will be provided to the Human Research Program. The protocol developed for the SDTO provided valuable insight into crew comfort issues, design improvements, and loading preferences for exercise harnessing, and lays the groundwork for better harnessing systems and training protocols.

Stories

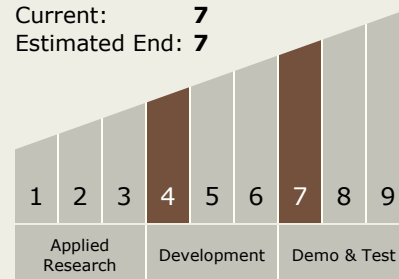
Abstracts for Journals and Proceedings
(<https://techport.nasa.gov/file/46541>)

Abstracts for Journals and Proceedings
(<https://techport.nasa.gov/file/46540>)

Articles in Peer-reviewed Journals
(<https://techport.nasa.gov/file/46542>)

Technology Maturity (TRL)

Start: **4**
Current: **7**
Estimated End: **7**



Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
 - TX06.3 Human Health and Performance
 - TX06.3.2 Prevention and Countermeasures

Target Destinations

The Moon, Mars

Human Spaceflight Capabilities

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Awards

(<https://techport.nasa.gov/file/46543>)

Project Website:

<https://taskbook.nasaprs.com>